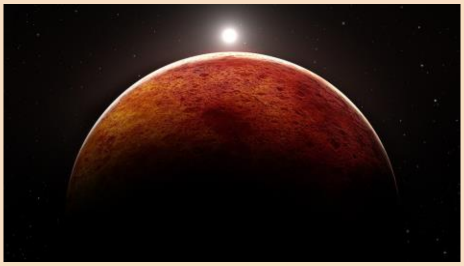
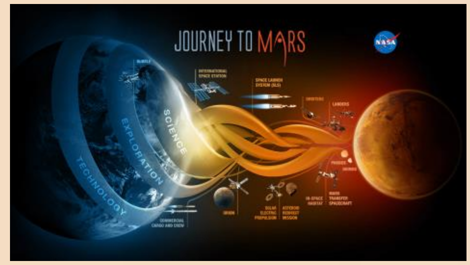


Martian Colonization



The year is 2045. NASA, with the blessing of the International Space Exploration Coordination Group, (an alliance of 15 countries which hopes to expand human presence in space), has successfully integrated a small colony of 24 people on Mars. The small colony (named **Odysseus** after the Greek hero who embarked on an epic journey to find his way home) is thriving; however, with their success comes questions concerning the future of Odysseus and colonization of Mars in general.

Mars is a terrestrial planet located 50% farther from the Sun than Earth. This means that while Mars has a terrain for humans to walk on, unlike the surface-less gas giants, Mars is much colder than Earth. The average temperature is around **-80°F**, making it too cold for humans to inhabit. Furthermore, Mars' **gravitational pull** is about ⅓ the strength of Earth's. This means that colonists can jump long distances with minimal effort, but are at risk to heart complications and lower bone density associated with a lower or zero gravity.

All evidence indicates that billions of years ago, Mars had an **atmosphere** and **geosphere** (geologic makeup) similar to Earth's; however, at some point in time **tectonic movement** and volcanic activity gradually began to cease, transforming Mars into a "dead" planet. Without tectonic movement, Mars lost the **magnetosphere** protecting its upper atmosphere from solar winds (imagine a giant magnet pushing away other magnetic objects that you throw at it – the same idea applies to a planet). In a similar line, when Mars lost its volcanic activity the planet lost its ability to "recycle" materials between its atmosphere and geosphere. This meant that when carbon dioxide from the atmosphere was absorbed into its surface, it became locked there for eternity. This further stripped the atmosphere and surface from materials important for life.

Though Mars has lost the capacity to host advanced life, it still contains all the prerequisite compounds necessary for it. With the successful integration of Odysseus on Mars, governments, space agencies and the public are clamoring for further Martian colonization. NASA and the ISECG are worried about meeting the demand with the limited capacity of the bubble pods currently used to house the **Argonauts** (the term for Martian astronauts, named after the Greek heroes who accompanied Jason on his quests), their food and their supplies. Furthermore, the population of Earth has expanded to a staggering 9 billion people, a size that is quickly consuming remaining food and water resources. The strain on our home planet has astronomically increased the demand for rapid colonization on Mars. With these circumstances in mind, NASA and the ISECG are considering various options to expand further colonization:

1. **Terraforming Mars**

   This involves introducing a powerful greenhouse gas that will warm the planet by trapping heat in the lower atmosphere. These greenhouse gases would work in tandem with engineered microbes optimized for oxygen and nitrogen production. Together they would thicken and warm the atmosphere with the proper ratio of oxygen and nitrogen needed for life, though humans would still be required to wear breathing apparatuses outside. Due to the massive scale of the project, terraforming the entire planet would take at least 50 years. This solution is seen as the most permanent option.

2. **Para-terraforming part of Mars**

In this scenario, NASA would find several nice, roomy caverns – of which there are plenty on Mars – which could house a very large number of people. Steps would then be taken to pressurize the cave and create a biosphere as close to Earth as possible. This would include the use of engineered microbes and plants to colonize the soil and improve the ratio of oxygen and nitrogen in the air. This option would only take about five years to implement and would also protect the inhabitants from solar radiation.

3. **Keep with the bubbles**

   Technology is constantly improving. A small group of people at NASA believe that such drastic measures as terraforming and para-terraforming should not be undertaken unless an imminent threat to the survival of the human race presents itself. This group is confident that pressurized bubble pods can provide more than enough living-room for the increasing Martian population, especially if genetically modified organisms are used as food sources. Genetically modified organisms would be optimized to grow with as little space and sunlight as possible, and may potentially be hardy enough to survive outside.

4. **The human race as we know it is done, lets genetically engineer ourselves**

   This option is one touted by none in NASA and the ISECG but by a growing minority of the general population. This group believes that a new super race of humans should be developed in tandem to the terraformation of Mars. This new race would be bred to accommodate the extremely low gravity and the mountaintop-like conditions of an altered Mars without breathing apparatuses or medical side effects associated to extended stays in low gravity.

NASA has assembled a committee to determine the future of Martian colonization. For a more informed decision, the space agency has decided to include a team of synthetic biologists on the committee (you and your team). The previous four options are the only avenues possible for future colonization. Utilizing your knowledge of synthetic biology, pick a plan, or merge multiple plans, to move forward with in colonizing Mars. When formulating your plan, keep in mind you are also responsible for determining how synthetic biology will play a role in further colonization, and the costs and benefits of utilizing your plan in regards to synthetic biology.

Some questions to keep in mind while you make your decision:

1. What are the ethical implications of engineering humans?
2. Should synthetic biology and genetic engineering be used to change the atmosphere of a planet?
3. What are the implications of editing plants and establishing separate evolutionary trends than what would occur on Earth?
4. What kind of problems can you think of from permanently placing humans in a lower gravity, and how could we overcome these obstacles?
5. To prevent inbreeding and a culmination of genetic diseases in a gene pool, a permanent colony must have at least 10,000 members, and some suggest at least 40,000. Which method might be the most conducive to establishing such a large colony, in terms of both available time and space?

References

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Group Planning Sheet

1. **Should we continue to colonize Mars? Why or why not?**

2. **If so, by what methods should we go about furthering the colonization of Mars?**

3. **What are the three greatest obstacles in implementing your plan, and how do you think synthetic biology could be used to overcome these obstacles?**

4. **A large minority of the population is concerned with the ethical implications of your plan. What ethical issues are evident in your plan, and how can you address these issues to ease the concerns of the public?**